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FIRST YEAR SCIENCE – FIRST SEMESTER
PHYSICS (HONOURS)
PAPER - I (THEORY) [C-I THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT – I

Calculus :

Calculus of functions of more than one variable : Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

Dirac Delta function and its properties :

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

UNIT – II

Orthogonal Curvilinear Coordinates :

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. Comparision of velocity and acceleration in cylindrical and spherical coordinate system.

UNIT – III

Vector Calculus :

Recapitulation of vectors : Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector triple product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

UNIT – IV

Vector Differentiation : Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field and their physical significance. Del and Laplacian operators. Vector identities.

UNIT – V

VECTOR Integration : Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

[TOTAL THEORY CREDIT - 4]

Reference Books :

- Mathematical Methods for Physicist, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Codington, 2009, PHI learning.
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5th Ed., 2012, Jones and Bartlett Learning.
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F. Riley & M.P. Hobson, 2011, Cambridge University Press.
- Mathematical Physics and Special Relativity – M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan) 2nd Edition, 2009.
- Mathematical Physics – H.K. Das, Dr. Rama Verma (S. Chand Higher Academics) 6th Edition, 2011.
- Mathematical Physics – C. Harper, (Prentice Hall India) 2006.
- Mathematical Physics – Goswami (Cengage Learning) 2014.
- Mathematical Method for Physical Sciences – M.L. Boas (Wiley India) 2006.

FIRST YEAR SCIENCE – FIRST SEMESTER
PHYSICS (HONOURS)
PAPER - I (PRACTICAL) [C-I LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlights the use of computational methods to solve physical problems*
- *The course will consist of lectures (both theory and practical) in the Lab*
- *Evaluation done not on the programming but on the basis of formulating the problem*
- *Aim at teaching students to construct the computational problem to be solved*
- *Students can use any one operating system Linux Microsoft Windows*

Topics	Description with Applications
Introduction and overview	Computer architecture and organization, memory and input/output devices.
Basic of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.

Errors and error Analysis	Truncation and round of errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (*If---statement. If---else Statement. Nested if Structure. Else---if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops)*, Arrays (*1D & 2D*) and strings, user defined functions, Structures and Unions, Idea of classes and objects.
Programs:	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, binary search.
Random number generation	Area of circle, area of square, volume sphere, value of π.

Laboratory based experiments:

1. Determination of Surface Tension of water by capillary rise method.
2. Verification of 1st law of transverse vibration of string and hence to find out the absolute frequency.
3. Determination of velocity of sound at 0° C.
4. Determination of Young modulus (Y) of Indian Rubber.
5. Determination of specific heat of liquid by method of cooling.

Referred Books :

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++, J. Hubbard, 2000, McGraw---Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. 2007, Cambridge University Press.
- A First Course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
- Numerical Methods for Scientists & Engineering, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics, T. Pang, 2nd Edn., 2006, Cambridge Univ. Press.

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FIRST YEAR SCIENCE – FIRST SEMESTER
PHYSICS (HONOURS)
PAPER - II (THEORY) [C-II THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT – I

Rational Dynamics :

Centre of Mass and Laboratory frames. Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

Non-Inertial System :

Non-Inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications.

UNIT – II

Elasticity :

Relation between Elastic constants. Twisting torque on a Cylinder or Wire.

Fluid Motion :

Kinematics of Moving fluids: Poiseuille's Equation for Flow of Liquid through a Capillary Tube.

Gravitation :

Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.

UNIT – III

Central Force Motion :

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbit. Weightlessness. Basic idea of global positioning system(GPS). Physiological effects on astronauts.

UNIT – IV

Oscillations : SHM: Simple Harmonic Oscillation. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillation: Transient steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

UNIT – V

Special Theory of Relativity : Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of event. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition velocities. Variation of mass with velocity. Mass less Particles. Mass energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- An Introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, Vol. I, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill
- Physics, Resnik, Halliday and Walker, 8/e, 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday, 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education.
- Introduction to Special Relativity, R. Resnik, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003 Thomson Books / Cole.

Additional Books for Reference :

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics, F.W. Sears, M.W. Zemansky, H.D. Young, 13/e, 1986, Addison Wesley.
- Physics for Scientist and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning.
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
- Mechanics – J.C. Slater and N.H. Frank (McGraw-Hill)

FIRST YEAR SCIENCE – FIRST SEMESTER
PHYSICS (HONOURS)
PAPER - II (PRACTICAL) [C-II LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. To study the random error in observations.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine 'g' and velocity for a freely falling body using Digital Timing Technique.
6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).

7. To determine the Young's Modulus of a Wire by optical Lever Method.
8. To determine the Modulus of Rigidity of a wire by Maxwell's needle.
9. To determine the elastic Constant of a wire by Searle's method.
10. To determine the value of 'g' using Bar Pendulum.
11. To determine the value of 'g' using Katter's Pendulum.
12. Determination of coefficient of viscosity of viscous liquid by Stoke's method.
13. Determination of rigidity modulus of wire by static method.

Reference Books :

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985,Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.

FIRST YEAR SCIENCE – SECOND SEMESTER
PHYSICS (HONOURS)
PAPER - III (THEORY) [C-III THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT – I

Electric Field and Electric Potential :

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.

UNIT – II

Electrostatic energy of system of charges. Electrostatic energy of charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

UNIT – III

Dielectric Properties of Matter :

Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E, P** and **D**. Gauss' Law in dielectrics.

UNIT – IV

Magnetic Field : Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Critical Law its proof and its application to Solenoid its differential and integral form. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.

UNIT – V

Magnetic Properties of Matter : Magnetization vector (**M**). Magnetic Intensity (**H**). Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis.

Electromagnetic Induction : Faraday's Law, its integral and differential form. Lenz's Law. Self Inductance and Mutual Inductance. Energy stored in a Magnetic Field.

Electrical Circuits : Transient Current. Kirchoff's Laws for slowly varying current and basic integro differential equation of circuit theory, growth and decay of current in series LR, RC, LC and LRC circuits. A.C. voltage applied to LR, RC, LC and LCR series circuits, Power of LCR circuit. Complex Impedance and reactance. Series LCR circuits: (1) Resonance (2) Power dissipation (3) Quality factor and (4) Band width. Parallel LCR circuit.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Electricity, Magnetism & Electromagnetic Theory, S Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics . D.J Griffiths , 3rd Edn., 1998 ,Benjamin Cummings.
- Feynman lectures Vol.2 R.P. Feynman, R.B. Leighton, M Sand, 2008, Person Education
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood, Vol. I, 1991, Oxford Univ., Press.

FIRST YEAR SCIENCE – SECOND SEMESTER
PHYSICS (HONOURS)
PAPER - III (PRACTICAL) [C-III LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De'Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx).
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q and (d) Band width.

11. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonant frequency and (b) Quality factor.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer.
13. Determine of a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.
16. Draw the static characteristics of a diode valve and hence calculate plate resistance (rp).
17. Draw the static and mutual characteristics of a triode valve and hence find the amplification factor.
18. Compare the emf's of the supplied two cells using stretched wire potentiometer.
19. Verification of magnetic field along the axis of a circular coil.
20. Determination of the magnetic field at the center of a circular coil and hence show its variation with numbers of turns of the coil.

Reference Books :

- Advance Practical Physics for students, B.L. Flint and H.T. Wosnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.

FIRST YEAR SCIENCE – SECOND SEMESTER
PHYSICS (HONOURS)
PAPER - IV (THEORY) [C-IV THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT – I

Geometrical optics :

Fermat's principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics. Idea of dispersion. Application to thick lens, Ramsden and Huygens eyepiece.

Wave Motion :

Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.

UNIT – II

Superposition of two perpendicular Harmonic Oscillations :

Geographical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses. Superposition of N harmonic waves.

Wave Optics : Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle, verification of laws of reflection and refraction. Temporal and Spatial Coherence.

UNIT – III

Interference : Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.

UNIT – IV

Interferometer : Michelson Interferometer: (1) Construction, Theory and working. Shape of fringes, (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index and (5) Visibility of Fringes. Fabry-Parot interferometer and determination of wavelength of monochromatic light.

UNIT – V

Fraunhofer Diffraction : Single slit Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.

Fresnel Diffraction : Fresnel's Assumptions. Fresnel's Half-Period Zones for plane Wave. Explanation of Rectilinear Propagation of Light. Theory of Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel's diffraction pattern of a straight edge, a slit and a wire.

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INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Waves: Berkeley Physics Course, Vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamental of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill.
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill.
- The Physics of Vibrations and Waves, H.J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998,Tata McGraw Hill.
- Optics – Brijlal & Subramaniam – (S. Chand Publication) 2014.
- Geometrical and Physical Optics – R.S. Longhurst, Orient Blackswan, 01-Jan-1986.
- Vibrations and Waves – A.P. French, (CBS) Indian print 2003.
- Optics, E. Hecht (Pearson India).

FIRST YEAR SCIENCE – SECOND SEMESTER
PHYSICS (HONOURS)
PAPER - IV (PRACTICAL) [C-IV LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda^2 - T$ law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster's focusing; determination of angle of prism.
5. To determine refractive index of a Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine the refractive index (μ) of the supplied solid and liquid using Travelling Microscope.

Reference Books :

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani

SECOND YEAR SCIENCE – THIRD SEMESTER
PHYSICS (HONOURS)
PAPER - V (THEORY) [C-V THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT – I

Fourier Series : Periodic function. Orthogonality of sine and cosine functions. Dirichlet conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary periods.

UNIT – II

Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of infinite series. Term by term differentiation and integration of Fourier series. Parseval identity.

Some special functions : Beta and Gamma functions and relation between them. Expression of Integrals in terms of Gamma Functions.

UNIT – III

Frobenius Method and Special Functions : Singular points of second order Linear Differential Equations and their importance. Frobenius method and its applications to differential equation. Hermite differential equation. Properties of Hermite Polynomials. Rodrigues Formula. Generating Function Orthogonality. Simple recurrence relations.

UNIT – IV

Series solution of Legendre differential Equation. Properties of Legendre Polynomial. Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of Function in a series of Legendre Polynomials. Associated Legendre Polynomials and spherical harmonics.

UNIT – V

Theory of Errors : Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Errors.

Partial Differential Equations : Solutions to partial differential equations, using separation of variables. Laplace's equation in problems of rectangular, cylindrical and spherical symmetry. Conducting and dielectric sphere in an external uniform electric field. Wave equation and its solution for vibrational modes of stretched string.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

[TOTAL THEORY CREDIT - 4]

(18)

Reference Books :

- Mathematical Method for Physicist: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicist: Susan M. Lea, 2004, Thomson Books / Cole.
- Differential Equations: George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers: S.J. Farlow, 1993, Dover Pub.
- Mathematical Methods for Scientists & Engineers: D.A. McQuarrie, 2003, Viva Books.
- Mathematical Physics and Special Relativity: M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan) 2nd Edition, 2009.
- Mathematical Physics: H.K. Dass, Dr. Rama Verma (S. Chand Higher Academics) 6th Edition, 2011.
- Mathematical Physics: C. Harper (Prentice Hall India), 2006.
- Mathematical Physics: Goswami (CENGAGE Learning), 2014.
- Mathematical Method for Physical Sciences: M.L. Boas (Wiley India), 2006.
- Mathematics for Physicists, P. Dennery and A. Krzywicki Dover).
- Advance Engineering Mathematics : E. Kreyszig (New Age Publication), 2011.

SECOND YEAR SCIENCE – THIRD SEMESTER
PHYSICS (HONOURS)
PAPER - V (PRACTICAL) [C - V LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

The aim of this Lab is to use the computational method to solve physical problems. Course will consist of lectures (Both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Topics	Description with Applications
Introduction to Numerical computation software Scilab	Introduction to Scilab. Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initializing variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational & logical operators, the while loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (2), User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional

	arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2).
Curve fitting, lest square fit, Goodness of fit, standard deviation	Ohms law to calculate R, Hooke's law to calculate spring constant.
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, eigen values problems	Solution of mesh equations of electric circuits (3 meshes), Solution of coupled spring mass systems (3 masses).
Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods, Second order differential equation. Fixed difference method	First order differential equation. • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Second order Differential Equation • Harmonic oscillator (no friction) • Damped Harmonic oscillator • Over damped • Critical damped • Oscillatory • Forced Harmonic oscillator • Transient and • Steady state solution • Apply above to LCR circuits also

Laboratory based experiments:

1. Verification of 2^{nd} law of transverse vibration of string.
2. Verification of 3^{rd} law of transverse vibration of string.
3. Determination of rigidity modulus of wire by dynamic method.
4. Resolving power of plane diffraction grating.
5. Draw I – D curve hence determine the refractive index (μ) of the material of the prism given $<A = 60^0$.

Referred Books :

- Mathematical Methods for Physics and Engineers, K.F. Riley, M.P. Hobson and S.J..20 Bence, 3^{rd} Edn., 2006, Cambridge University Press.
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8^{th} Edn., 2011, Cambridge University Press.

- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.
- Simulation of ODE / PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernandez, 2014, Springer.
- Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444.
- Scilab (A free software to Matlab): H. Ramchandran, A.S. Nair, 2011, S. Chand & Company.
- Scilab Image Processing: Lambert M. Surhone, 2010, Betascript Publishing.

SECOND YEAR SCIENCE – THIRD SEMESTER
PHYSICS (HONOURS)
PAPER - VI (THEORY) [C-VI THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT – I
Introduction to Thermodynamics

Recapitulation of Zeroth and First law of thermodynamics :

Second Law of Thermodynamics : Reversible Irreversible process with examples. Conservation of Work in to Heat in to Work. Heat Engines. Carnot's cycle, Carnot engine and efficiency. Refrigerator and Coefficient of performance, 2nd Law of Thermodynamics: Kelvin – Planck and Clausius Statement and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic scale of Temperature and its Equivalence to Perfect Gas Scale.

UNIT – II
Entropy : Concept of Entropy, Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of perfect gas. Principle of increase of entropy. Entropy changes in Reversible and Irreversible processes with Examples. Entropy of the Principle of increase of entropy. Temperature Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

UNIT – III
Thermodynamic Potentials : Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definition, First and second order Phase Transitions with Examples, Clausius Clapeyron Equation and Eherenfest Equations.

Maxwell's Thermodynamic Relations : Derivations and Applications of Maxwell's Relations, Maxwell's Relations: (1) Clausius Clapeyron equation, (2) Values of C_p-C_v, (3) Tds Equations, (4) Joule-Kelvin coefficient for ideal Van der Waal Gases, (5) Energy Equations, (6) Change of Temperature during Adiabatic Process.

UNIT – IV
Kinetic Theory of Gases

Distribution of Velocities : Maxwell-Boltzmann Law of Distribution of Velocities in Ideal Gas and its Experimental Verification. Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heat of gases.

Molecular Collisions : Mean Free path. Collision of Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

UNIT – V

Real Gases : Behavior of Real Gases: Derivations from the Ideal Gas Equation. The virial Equation … Continuity of Liquid and Gaseous State, Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect For Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

[TOTAL THEORY CREDIT - 4]

Reference Books :

- Heat and Thermodynamics: M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treaties on Heat, Meghnad Saha and B.N. Srivastava, 1958, Indian Press.
- Thermal Physics: S. Garg, R. Bansal and Ghosh, 2nd Edn., 1993, Tata McGraw-Hill.
- Modern Thermodynamics with Statistical Mechanics: Carl S. Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics: Sears & Salinger, 1988, Narosa.
- Concept in Thermal Physics: S.J. Blundell, 2nd Edn., 2012, Oxford University Press.
- Heat and Thermal Physics: Brijlal & Subramanian (S. Chand Publication) 2014.
- Thermal Physics: C. Kittel and H. Kroemer (McMillan Education India) 2010.

SECOND YEAR SCIENCE – THIRD SEMESTER
PHYSICS (HONOURS)
PAPER - VI (PRACTICAL) [C-VI LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. To determine the Mechanical Equivalent of Heat 'J' by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. Determination of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. Variation of Thermo-emf of a Thermocouple with difference temperature of its two junctions.
7. To calibrate a thermocouple to measure temperature in a specified range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.
8. J – by Joule's Calorimeter.
9. Pressure Coefficient of air by constant volume thermometer.

Reference Books :

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani

SECOND YEAR SCIENCE – THIRD SEMESTER
PHYSICS (HONOURS)
PAPER - VII (THEORY) [C-VII THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT-I

Integrated Circuits (Qualitative treatment only): Active & Passive Components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of Integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs.

UNIT-II

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOR Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.

UNIT-III

Boolean Algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuits using Boolean Algebra. Fundamental Products. Ideas of Minterms and Maxterms. Conversion of a Truth table in to Equivalent Logic Circuit by (1) Sum of Products Method and Karnaugh Map.
Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full adders. Half and Full Subtracters, 4-bit binary Adder/Subtracter

UNIT-IV

Introduction to CRO: Block diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Wave Form, (2) Measurement of Voltage, Current, Frequency and Phase Difference.
Data Processing Circuits: Basic Idea of Multiplexers, De-multiplexers, Decoders Encoders.
.Timers: IC 555: block Diagram and Applications: Astable Multivibrator and Monostable multivibrator.

UNIT-V

Introduction to Computer Organization: Input/Output Devices. Data Storage (Idea of RAM and ROM). Computer memory. Memory organization and addressing. Memory Interfacing. Memory Map.
Shift registers: Serial-in-Serial-out, Serial-in Parallel-out, Parallel-in-Serial-out and parallel-in-Parallel-out Shift Registers (only up to 4 bits).
Counters(4 bits): Ring Counter. Asynchronous Counters. Decade Counter. Synchronous Counter.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Digital Principles and Applications: A.P. Malvino, D.P. Leach and Saha, 7th Edn., 2011, Tata McGraw-Hill.
- Fundamentals of Digital Circuits: Anand Kumar, 2nd Edn., 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and Systems: Venugopal, 2011, Tata McGraw-Hill.
- Digital Systems: Principles Applications, R.J. Tocci, N.S. Widmer, 2001, PHI Learning Pvt. Ltd.
- Logic Circuit Design: Shimon P. Vingron, 2012, Springer.
- Digital Electronics: Subrata Ghoshal, 2012, Cengage Learning.
- Microprocessor Architecture Programming & Applications with 8085, 2002, R.S. Goankar, Prentice Hall.
- Concept of Electronics: D.C. Tayal, (Himalay Publication),2011.
- Electronics: V.K. Meheta (S. Chand Publication) 2013.
- The Art of Electronics: P. Horowitz and W. Hill, CUP.

SECOND YEAR SCIENCE – THIRD SEMESTER
PHYSICS (HONOURS)
PAPER - VII (PRACTICAL) [C-VII LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. To measure (a) Voltage and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using transistor.
4. To verify AND, OR, NOT AND XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs.
12. To build a 4-bit Counter using D-type / JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type / JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.
16. Verification of the truth tables of different logic gates.
17. Determination of reduction factor of a Tangent Galvanometer.
18. Determination of unknown high resistance using Mega ohm box.
19. Determination of figure of merit of a galvanometer.

Reference Books :

- Modern Digital Electronics, R.P. Jain, 4th Edn., 2010, Tata McGraw Hill.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, McGraw Hill.
- Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
- Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.
- Advanced Practical Physics by Prof. B.B. Swin.

SECOND YEAR SCIENCE – FORTH SEMESTER
PHYSICS (HONOURS)
PAPER - VIII (THEORY) [C-VIII THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT-I

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of Analytic functions.

UNIT-II

Singular functions: Poles and Branch points, Order of Singularity, branch cuts. Integration of a function of a Complex Variable. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Recidue Theorem. Application in solving Definite Integrals.

UNIT-III

Integral Transforms:

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of Trigonometric, Gaussian, finite wave train and other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transforms of derivatives

UNIT-IV

InverseFourier transforms and convolution theorem. Properties of Fourier transforms .Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

UNIT-V

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit tep Function, Dirac Delta function, periodic Functions. Convolution Theorem. Inverse LT. application of Laplace Transforms to Differential Equations.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Mathematical Methods for Physics for Physics and Engineers: K.F. Riley, M.P. Hobson and S.J. Bence, 3rd Edn., 2006, Cambridge University Press.
- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Advanced Engineering Mathematics: E. Kreyszig (New Age Publication), 2011.

- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications.
- Complex Variables:A.S. Fokas & M.J. Ablowitz, 8th Edn., 2011, Cambridge Univ. Press.
- Complex Variables and Applications: J.W. Brown and R.V. Churchill, 7th Edn., 2003, Tata McGraw-Hill.
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Zones and Bartlett.
- Mathematical Physics: H.K. Das, Dr. Rama Verma (S. Chand Higher Academics), 6th Edn., 2011.
- Mathematical Physics: C. Harper (Prentice Hall India) 2006.
- Mathematical Physics: Goswami (Cengage Learning), 2014.
- Mathematical Method for Physical Sciences: M.L. Boas (Wiley India), 2006.
- Introduction to the Theory of Functions of a Complex Variables: E.T. Copson (Oxford) Univ. Press, 1970.

FOURTH

SECOND YEAR SCIENCE – THIRD SEMESTER
PHYSICS (HONOURS)
PAPER - VIII (PRACTICAL) [C-VIII LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

Scilab based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:
   $dy/dx = e^{-x}$ with $y = 0$ for $x = 0$
   $dy/dx + e^{-x}y = x^2$
   $d^2y/dt^2 + 2\, dy/dt = -y$
   $d^2y/dt^2 + e^{-t}dy/dt = -y$.
2. Calculation of least square fitting manually without giving weightage to error. Conformation of least square fitting of data through computer program.
3. Evaluation of trigonometric functions e.g. *sin θ,* Given Bessel's functions at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.
4. Integral transform: FFT of e^{-x2}.

Laboratory based experiments:

5. Determination of 'Y' by bending of beam method.
6. Determination of surface tension of mercury by Quinck's method.
7. Determination of 'G' by Kelvin's method.
8. To the Millikan's oil drop apparatus and determine the charge of an electron.
9. To determine the wavelength of unknown light by drawing calibration curve of prism spectrometer.

Reference Books :

- Mathematical Methods for Physics and Engineers, K.F. Riley, M.P. Hobson and S.J. Bence, 3rd Edn., 2006, Cambridge University Press.
- Mathematics for Physicists: P. Dennery and A. Krzywicki,1967, Dover Publications.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVEE and SCILAB: Scientific and Engineering Applications: A. Vande, Wouwer, P. Saucez, C.V. Fernandz, 2014, Springer ISBN: 978-3319067896.
- Scilab by example: M. Affouf, 2012, ISBN:978-1479203444.
- Scilab (A free software to Matlab): H. Ramchandran, A.S. Nair, 2011, S. Chand and Company.
- Scilab image Processing: Lambert M. Surhone, 2010, Betascript Publishing.

SECOND YEAR SCIENCE – FORTH SEMESTER
PHYSICS (HONOURS)
PAPER - IX (THEORY) [C-IX THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT-I

Atomic Spectra and Models: Atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle. Alpha particle Scattering, Rutherford Scattering Formula, Rutherford Model of atom and its limitations, Bohr's model of H atom, explanation of atomic spectra, correction for finite mass of nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Expt. Sommerfeld's Modification of Bohr's Theory.

UNIT-II

Wave Particle Duality: Inadequacy of classical physics, Brief Review of Black body Radiation, Photoelectric effect, Compton effect, dual nature of radiation, wave nature of particles De Broglie hypothesis, Experimental confirmation of matter wave, Davisson Germer Experiment, velocity of de Broglie wave, wave particle duality, Complementarity. Superposition of two waves, phase velocity and group velocity, wave packets, Gaussian Wave Packet, spatial distribution of wave packet, Localization of wave packet in time.

UNIT-III

Time development of wave packet; Wave particle duality, Complementarity. Heisenberg Uncertainty Principle, Illustration of the Principle through Experiments of Gamma ray microscope and electron diffraction through a slit. Estimation of ground state energy of harmonic oscillator and hydrogen atom, Non existence of electron in the nucleus. Uncertainty and Complementarities.

UNIT-IV

Nuclear Physics:

Size and Structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of uncertainty principle, nature of nucleus force, NZ graph, Liquid Drop Model: semi-empirical mass formula and binding energy, Nuclear Shell Model and Magic numbers.

UNIT-V

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay-energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of nucleus. Displacement law and successive disintegration

Fission and Fusion- mass deficit, relativity and generation of energy;

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Concepts of Modern Physics: Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics: Rich Meyer, Kennard, Cop, 2002, Tata McGraw-Hill.
- Introduction to Quantum Mechanics: David J. Grifffith, 2005, Pearson Education.
- Physics for Scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Quantum Mechanics: Theoy & Applications, A.K. Ghatak & S. Lokanathan, 2004, McMillan.
- Modern Physics – Bernstein, Fishbane and Gasiorowicz (Pearson India), 2010.
- Quantum Physics of atoms, molecules, solids, nuclei and particles: R. Eisberg (Wiley India), 2012.
- Modern Physics: Murugesan and Sivaprasad (S. Chand Higher Academics).
- Physics of Atoms & Molecules: Bransden (Pearson India), 2003.

FOURTH

SECOND YEAR SCIENCE – THIRD SEMESTER
PHYSICS (HONOURS)
PAPER - IX (PRACTICAL) [C-IX LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. Measurement of Planck's constant using black body radiation and photo detector.
2. Photoelectric effect: Photo current versus intensity and wavelength of light, maximum energy of photo electron versus frequency of light.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-Alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar Magnet.
9. To determine the wavelength of laser source using diffraction of single slit.

Reference Books :

- Advance Physics Practical by Prof. B.B. Swin.
- Advance Physics Practical by C.L. Arora.

SECOND YEAR SCIENCE – FORTH SEMESTER
PHYSICS (HONOURS)
PAPER - X (THEORY) [C-X THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT-I

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.

UNIT-II

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.

UNIT-III

Bipolar Junction Transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β, Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. Classification of class A, B and C Amplifiers.

UNIT-IV

Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. RC-coupled amplifier and its frequency response.

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

UNIT-V

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase Shift oscillator, determination of Frequency. Heartly & Colpitts oscillators.

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and Concept of Virtual ground.

Applications of Op-Amps: (1) inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector, (8) Wein bridge oscillator.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Integrated Electronics: J. Millman and C.C. Halkias, 1991, Tata McGraw-Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices: B.G. Streetman & S.K. Banerjee, 6th Edn., 2009, PHI Learning.
- Electronic Devices & Circuits, S. Salivahanan & N.S. Kumar, 3rd Edn., 2012, Tata McGraw Hill.
- OP-Amps and linear Integrated Circuit: R.A. Gayakwad, 4th Edn., 2000, Prentice Hall.
- Electronic Circuits: Handbook of design & applications, U. Tietze, C. Schenk, 2008, Springer.
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Edn., 2002, Wiley India.
- Electronic Devices: 7th Edn., Thomas L. Floyd, 2008, Pearson India.
- Concept of Electronics: D.C. Thayal (Himalaya Publication), 2011.
- Electronic Devices: Circuits & Applications: W.D. Stanley, Prentice Hall.
- Electronics: V.K. Meheta (S. Chand Publication), 2013.
- Electronic Circuits: L. Schilling and Velove: 3rd Edn., McGraw Hill.
- Electronics: Raskhit and Chattopadyay, New Age International Publication, 2011.
- Electricity and Electronics: D.C. Thayal, Himalaya Publication, 2011.
- Electronic Devices and Circuits: R.L. Boylstad (Pearson India), 2009.

SECOND YEAR SCIENCE – FORTH SEMESTER
PHYSICS (HONOURS)
PAPER - X (PRACTICAL) [C-X LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. To study V-I characteristics of PN Junction diode and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration / CB configuration.
5. To study the various biasing configuration of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.

7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To design a digital to analog converter (DAC) of given specifications.
11. To study the analog to digital converter (ADC) IC.
12. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain.
13. To design inverting amplifier using Op-amp (741,351) and study its frequency response.
14. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response.
15. To study the zero-crossing detector and comparator.
16. To add two dc voltages using Op-amp in inverting and non-inverting mode.
17. To design a precision Differential amplifier of given I/O specification using Op-amp.
18. To investigate the use of an op-amp as an Integrator.
19. To investigate the use of an op-amp as a Differentiator.
20. To design a circuit to stimulate the solution of a 1^{st} / 2^{nd} order differential equation.

Reference Books :

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, McGraw Hill.
- OP-Amps and Linear Integrated Circuit, R.A. Gayakwad, 4^{th} Edn., 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata McGraw Hill.
- Electronic Devices & Circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson.

THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER - XI (THEORY) [C-XI THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

Unit-I

Schrodinger equation & the operators: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for physical Acceptability of wave functions. Normalization, Linearity and Superposition principles. Hermitian operator, Eigen values and Eigen functions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle, Ehrenfest Theorem.

Unit-II

Time independent Schrodinger equation- Hamiltonian, stationary states and energy Eigen values; expansion of an arbitrary wave function as a linear combination of energy Eigen functions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to Spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Ehrenfest theorem (operator method), Quantum virial theorem.

Unit-III

Fourier transforms and momentum space wave function; Position-momentum uncertainty principle.General discussion of bound states in an arbitrary potential: continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions ground state, zero point energy & uncertainty principle.

Unit-IV

One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential and rectangular potential barrier.

Unit-V

Atoms in Electric and Magnetic Fields: Electron angular momentum. Space quantization. Electron spin and spin angular momentum. Larmor's Theorem. Spin magnetic moment. Stern-Gerlach Experiment. Zeeman Effect: Electron magnetic Moment and Magnetic Energy, Gyromagnetic ratio and Bohr Magneton.Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion Only).

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

[TOTAL THEORY CREDIT - 4]

Reference Books :

- A Text book of Quantum Mechanics: P.M. Mathews and K. Venkatesan, 2nd Edn., 2010, McGraw Hill.
- Quantum Mechanics, Robert Eisberg and Robert Resnik, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn., 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2nd Edn., 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press.
- Quantum Physics ---- S. Gasiorowicz (Wiley India), 2013.
- Quantum Mechanics – J.L. Powell and B. Craseman (Narosa) , 1988.
- Introduction to Quantum Mechanics – M. Das, P.K. Jena (SriKrishna Prakashan).
- Basic Quantum Mechanics – A. Ghatak (McMillan India), 2012.
- Introduction to Quantum Mechanics – R. Dicke and J. Wittke.
- Quantum Mechanics – Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Edn., 2005, Pearson Education.
- Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer.
- Quantum Mechanics – F. Mandl (CBS) 2013.
- Cohen-Tannoudji, B. Diu and F. Laloe, Quantum Mechanics, (2 vols) Wiley-VCH, 1977.

THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER - XI (PRACTICAL) [C-XI LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:
   Here, m is the reduced mass of the electron. Obtain the energy eigen values and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈-13.6 eV. Take e = 3.795 (eVÅ)1/2, hc = 1973 (eVÅ) and m = 0.511x106 eV/c2.
2. Solve the s-wave radial Schrodinger equation for an atom:
   Where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential.
   Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digit. Also, plot the corresponding wave function. Take e = 3.795 (eVÅ)1/2, m = 0.511x106 eV/c2, and a = 3 Å, 5 Å, 7 Å. In these units hc = 1973 (eVÅ). The ground state energy is expected to be above -12eV in all three cases.
3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

For the anharmonic oscillator potential
for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c2, k = 100 MeV fm-2, b = 0, 10, 30 MeV fm-3. In these units, ch = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule: Where μ is the reduced mass of the two-atom system for the Morse potential
Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.
Take: m = 940x106 eV/C2, D = 0.755501 eV, α = 1.44, ro = 0.131349 Å.

Laboratory based experiments:

5. Study of Electron spin resonance-determine magnetic field as a function of the resonance frequency.
6. Study of Zeeman effect with external magnetic field, Hyperfine splitting.
7. To show the tunneling effect in tunnel diode using I-V characteristics.
8. Quantum efficiency of CCDs.
9. To determine the diameter of narrow wire.
10. Verification of Brewster's law.
11. Callibration of meter bridge.
12. Determination of η of the given viscous liquid by Searle's viscometer.

Reference Books :

- Schaum's outline of Programming with C++, J. Hubbard, 2000. McGraw Hill Publication.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn., 2007, Cambridge University Press.
- An Introduction to Computational Physics: T. Pang, 2nd Edn., 2006, Cambridge University Press.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C.V. Fernandez, 2014, Spinger.
- Scilab (A free software to Matlab): H. Ramchandran, A.S. Nair, 2011, S. Chand & Co.
- Scilab Image Processing: L.M. Surhone, 2010,Betascript Publishing, ISBN:978-6133459274.
- Advance Practical Physics by Prof. B.B. Swin.

THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER - XII (THEORY) [C-XII THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT-I

Crystal structure: Solids: Amorphous and Crystalline Materials. Lattice translation Vectors. Lattice with a Basis – Central and Non-central Elements. Unit Cell, Weigner-Scitz Cell, SC, FCC, BCC and HCP Miller Indices. Types of Lattices, Reciprocal Lattice. Diffraction of X-Rays by Crystals. Bragg's Law. Brillouin Zones, Laue Condition, Bragg's law from Laue condition, Atomic form factor and Geometrical structure Factor.

UNIT II

Elementary Lattice Dynamics: Lattice Vibrations and phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye Theories of specific heat of Solids. T^3 law.

UNIT-III

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of Dia- and Paramagnetic Domains. Curie's law, Weiss theory of ferromagnetism and ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

UNIT-IV

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability.

Lasers: Einstein's A and B Coefficients. Metastable States. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Properties of Laser beam, Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser.

UNIT-V

Elementary band theory: Kronig Penny Model. Band Gap. Conductor, semiconductor (P and N type) and insulator. Conductivity of semiconductor, mobility, Hall effect. Measurement of conductivity (04 probe methord) and Hall coefficient.

Superconductivity: Experimental results. Critical temperature. Critical magnetic field. Meissner effect. Type I and type II superconductors, London's equation and penetration depth. Isotope effect. Idea of BCS theory(no derivation).

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

[TOTAL THEORY CREDIT - 4]

Reference Books :

- Introduction to Solid State Physics, Charles Kittel, 8th Edn., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, Prentice Hall of India.
- Introduction to solids: Leonid V. Azaroff, 2004, Tata McGraw Hill.
- Solid State Physics: S.O. Pillai, New Age Publication.
- Solid State Physics: R.K. Puri and V.K. Babber, S. Chand Publication.
- Lasers and Non Linear Optics: B.B. Laud, Wiley Eastern.
- LASERS: Fundamentals and Applications, Thyagarajan and Ghatak, McMillan India.

THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER - XII (PRACTICAL) [C-XII LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method).
2. To measure the magnetic susceptibility of solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To determine the dielectric constant of a dielectric material with frequency.
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon Resonance (SPR).
6. To determine the refractive index of a dielectric layer using SPR.
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using solenoid and determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by Four-probe method (room temperature to 150^0 C) and determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.
11. To determine H-component of earth's magnetic field and magnetic moment of a Bar magnet.

Reference Books :

- Advanced Practical Physics for Students: B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M Ogborn, 4th Edn., Reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edn., 2006, Prentice Hall of India.
- Advance Practical Physics by Prof. B.B. Swin.

THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER - XIII (THEORY) [C-XIII THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT-I

Maxwell Equations: Maxwell's equations. Displacement current. Vector and scalar potentials. Gauge transformations: Lorentz and coulomb gauge. Boundary conditions at interface between different media. Wave equations. Plane waves at dielectric media. Poynting theorem and poynting vector. Electromagnetic (EM) energy density. Physical concept of electromagnetic field energy density.

UNIT-II

EM wave propagation in unbounded media: Plane EM waves through vaccum and isotropic dielectric medium. Transverse nature of plane EM waves, refractive index and dielectric constant, wave impedence.Propagation through conducting media, relaxation time, skin depth. Electrical conductivity of ionized gases, plasma frequency, refractive idex, skin depth, application to propagation through ionosphere.

UNIT-III

EM wave in bounded media: Boundary conditions at a plane interference between two media. Reflection and refraction of plane waves at a plane interface between two dielectric media- Laws of reflection and refraction. Fesnel's formulae for perpendicular and parallel polarization cases, Brewster's law. Reflection and transmission coefficients. Total internal reflection , evanescent waves. Metallic reflection (normal incidence).

UNIT-IV

Polarization of electromagnetic waves: Description of linear, circular and elliptical polarization. Propagation of EM waves in anisotropic media. Symmetric nature of dielectric tensor. Fresnel's formula. Uniaxial and biaxial cryatals. Light propagation in uniaxial crystal. Double refraction . Polarization by double refraction. Nicol prism. Ordinary and extraordinary refractive indices. Production and detection of plane, circularly and elliptically polarized light.

UNIT-V

Phase retardation plates: Quarter-wave and half-wave plates. Babinet compensator and its uses. Analysis of polarized light.

Rotatory Polarization: Optical rotation, Biot's laws for rotatory polarization. Fresnel's theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter.

Optical fibres: Numerical aperture. Step and graded indices(definitions only). Single and multiple mode fibres(concept and definition only).

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

[TOTAL THEORY CREDIT - 4]

Reference Books :

- Introduction to Electrodynamics: D.J. Griffiths, Benjamin Cummings.
- Elements of Electromagnetics: M.N.O. Sadiku, 2001, Oxford University Press.
- Electricity and Magnetism: D.C. Tayal, Himalaya Publication.
- Introduction to Electrodynamics: A.Z. Capri and P.V. Panat (Alpha Science).
- Optics: E. Hecht (Pearson India).
- Electromagnetic Theory: A. Murthy, S. Chand Publication.
- Classical Electrodynamics: J.D. Jackson (Wiley India)

THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER - XIII (PRACTICAL) [C-XIII LAB]

Time – 6 Hours **Full Marks – 25**

(TOTAL PRACTICAL CREDIT – 2)

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized light by using Babinet's Compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study reflection and refraction of microwaves.
7. To study polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
9. To determine the refractive index of (1) Glass and (2) a liquid by total internal reflection using a Gaussian eye piece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To determine the Boltzmann constant using V-I characteristics of PN junction diode.
12. To determine η of a given liquid by oscillating disc method.

Reference Books :

- Advanced Practical Physics for Students: B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M Ogborn, 4th Edn., Reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edn., 2006, Prentice Hall of India.
- Electromagnetic Field Theory for Engineers and Physicists: G. Lehner, 2010, Springer.
- Advance Practical Physics by Prof. B.B. Swin.

THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER - XIV (THEORY) [C-XIV THEORY]

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT-I

Classical statistics: Macrostate and Microstate, elementary concept of ensemble, Microcanonical, canonical and grand canonical ensemble. Phase space, entropy and thermodynamic probability, Maxwell-boltzmann distribution law, partion function, Thermodynamic functions of an ideal gas, Classical entropy expression, Gibbs paradox, Sackur tetrode equation. Law of equipartition of energy (with proof) – applications to specific heat and its limitations, Thermodynamic functions of a two-energy levels system. Negative temperature.

UNIT-II

Radiation: Properties of thermal radiation. Black body radiation. Pure temperature dependence. Kirchhoff's law. Stefan-boltzmann law: Thermodynamic proof. Radiation pressure. Wien's displacement law. Wien's distribution law. Saha's ionization formula. Rayleigh-jean's law. Ultraviolet catastrophe.

UNIT-III

Planck's law of blackbody radiation: Derivation and experimental verification of Plank's law. Deduction of (1) wien's distribution law, (2) Rayleigh-jean's law, (3) Stefan-boltzmann law, (4) wien's displacement law from planck's law.

Differential equation of heat flow in one dimension, its solution, Ingen-Hausz experiment, Radial flow of heat in an isotropic medium.

UNIT-IV

Quantum statistics: Identical particles, macrostates and microstates. Fermions and Bosons, Bose Einstein distribution function and Fermi-dirac distribution function.

UNIT-V

Bose-Einstein condensation, Bose deviation from planck's law, Effect of temperature on F-D distribution function, degenerate fermigas, density of states, Fermi energy.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Statistical Mechanics: R.K. Pathria & Paul D. Beale (Academic Press).
- Statistical Physics, Berkeley Physics Course: F. Reif, 2008, Tata McGraw Hill.
- Statistical and Thermal Physics: S. Lokanathan and R.S. Gambhir, Prentice Hall.
- Statistical Physics: F. Mandl (CBS), 2012.
- Statistical Physics of Particles: M. Kardar (CUP), 2007.

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THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER - XIV (PRACTICAL) [C-XIV LAB]

Time – 6 Hours **Full Marks – 25**

(TOTAL PRACTICAL CREDIT – 2)

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

1. Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
2. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases.
3. Plot Maxwell-Boltzmann distribution function versus temperature.
4. Plot Fermi-Dirac distribution function versus temperature.
5. Plot Bose-Einstein distribution function versus temperature.

Laboratory based experiments:

6. Calibration of Sets' of weights taking 100 gm as standard.
7. To determine Y of wooden scale by vibrating Cantilever.
8. To determine λ of Laser by plane diffraction granting.
9. To determine resolving power of Telescope.
10. To study the Colpitt's oscillator.
11. To verify the Stefan's law of radiation and to determine Stefan's constant.

Reference Books :

- Elementary Numerical Analysis: K.E. Atkinson, 3rd Edn. 2007, Wiley India Edition.
- Statistical Mechanics: R.K. Pathria, Butterworth Heinemann, 2nd Edn. 1996, Oxford University Press.
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics: Carl S. Helrich, 2009, Springer.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C.V. Fernandez, 2014, Springer, ISBN: 978-3319067896.
- Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444.
- Scilab Image Processing: L.M. Surhone, 2010, Betascript Pub., ISBN: 978-6133459274.
- Advance Practical Physics by Prof. B.B. Swin.

THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:1 (THEORY)

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

Unit-I

Mechanics of system of particles, Generalised co ordinates D'Alemberts principle and Lagrange equation and its simple application .

Unit-II

Classical Mechanics of Point Particles: Generalized coordinates and velocities. Hamilton's Principle. Derivation of Langrangian and Eular-Langrange equations. Applications to simple systems such as coupled oscillators.

Unit-III

Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for harmonic oscillator, particle in central force field. Motion of charged particles in external electric and magnetic fields.

Unit-IV

Special Theory of Relativity: Postulates of Special Theory of relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space time diagrams. Time –dilation, length contraction and twin paradox.

Unit-V

Four vectors: space- like ,time-like and light like. Four velocity and acceleration. Metric and alternating tensor .Four momentum and energy- momentum relation. Doppler effect from a four vector perspective. Concepts of Four force .Conservation of Four momentum. Relativistics kinematics . Application to two body decay of an unstable particle.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Classical Mechanics: H. Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
- Mechanics: L.D Landau and E.M. Lifshitz, 1976, Pergamon.
- Classical Mechanics: An Introduction, Dieter Strauch, 2009, Springer.
- Solved problems in Classical Mechanics: O.L. Delange and J. Pierrus, 2010, Oxford Press.
- Classical Mechanics: J.C. Upadhyay (Himalaya Publication), 2014.
- Classical Dynamics of Particles and Systems: S.T. Thornton (Cengage Learning), 2012.
- Introduction to Classical Mechanics: R.K. Takwale, S. Puranik (Tata McGraw Hill).
- Classical Mechanics: M. Das, P.K. Jena, M. Bhuyan, R.N. Mishra (Srikrishna Prakashan)

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THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:1 (PRACTICAL)

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. To determine the Rigidity Modulus by Static method.
2. To determine the Rigidity Modulus by Dynamic method.
3. To determine the Young's modulus by double cantilever.
4. Verification of Stoke's law.
5. Study and draw static characteristics of P-N junction / Zener diode.
6. To determine the velocity of sound at 0^0 C.

Reference Books :

- Advanced Practical Physics for Students: B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M Ogborn, 4th Edn., Reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Advance Practical Physics by Prof. B.B. Swin.

THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:II (THEORY)

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

Unit-I

General Properties of nuclei: Constituents of nucleus and their intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

Unit-II

Nuclear models: Liquid drop model approach semi empirical mass formula and significance of its various terms , condition for its nuclear stability, two nucleon separation energies , evidence for nuclear shell structure nuclear magic numbers , basics assumption of shell model

Unit-III

Radioactive decay (a) Alpha decay basics of α decay process , theory of α emission Gamow factor , Gieger Nuttal law (b) β-decay ,positron emission , electron capture , neutrino hypothesis (c) Elementary of gamma decay

Nuclear reaction: Types of reaction ,conservation laws ,kinematics of reaction, Q-value

Unit-IV

Detector for nuclear Radiation: Gas detectors ,estimation of electric field ,mobility of particles ,for ionization chamber and GM counter .Basics principles of scintillation Detectors and construction of photo multiplier tube (PMT) Semiconductor (Ge and Si) detectors for charge particles and photon detection ,neutron detector.

Unit-V

Particle accelerator :Van de Graff generator(Tandem accelerator), Linear accelerator, Cyclotron ,synchrotrons.

Particle physics: Particle interaction; basic features ,types of particles and its families. Symmetric and conservation laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin strangeness and charm. Elementary ideas of quarks and gluons.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

[TOTAL THEORY CREDIT - 4]

Reference Books :

- Introductory Nuclear Physics by Kenneth (Wiley India Pvt. Ltd.), 2008.
- Concepts of Nuclear Physics by Bernard L. Cohen (Tata McGraw Hill), 1998.
- Introduction to High Energy Physics: D.H. Perkins, (Cambridge Univ. Press).
- Introduction to Elementary Particles: D. Griffith (John Wiley & Sons).
- Basic Ideas and Concepts in Nuclear Physics: An Introductory Approach by K. Heyde (IOP Institute of Physics Publishing), 2004.
- Theoretical Nuclear Physics: J.M. Blatt & V.F. Weisskopf (Dover Pub. Inc., 1991).
- Atomic and Nuclear Physics: A.B. Gupta, Dipak Ghosh (Books and Allied Publishers).
- Physics of Atoms and Molecules: Bransden (Pearson India), 2012.

THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:II (PRACTICAL)

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. To determine the Refractive Index of solid and liquid.
2. To determine the Refractive Index of prism by I-D curve method.
3. To determine the magnetic field at the center of the coil and hence to show its variation with numbers of turns of the coil.
4. To determine the figure of merit.
5. To determine e/m by Thomson method.
6. Verification of magnetic field along the axis of a circular coil.

Reference Books :

- Advanced Practical Physics for Students: B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M Ogborn, 4th Edn., Reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Advance Practical Physics by Prof. B.B. Swin.

THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:III (THEORY)

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

Unit-I

Introduction: Importance of computers in physics, paradism for solving physics problems for solution.Usage for linux as an editor.

Algorithm and flow chart: Algorithm :definition, properties and development ,Flow chart: concept of flow chart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrix, sum and product of finite series, calculation of sin(x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

Unit-II

Scientific Programming: Some Fundamental Linux Commands (Internal and External Commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of introduction and program. Operaters: Arithmetic, Relational, Logical and Assignment Operators.

Unit-III

Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Frotran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Frotran Program, Format of Writing program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

Unit-IV

Control Statements: Types of Logic (Sequential, selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DOWHILE, Implide and Nested DO Loops).

Unit-V

Jumping statements (Unconditional GOTO, Computed GOTO, Assigned GOTO), Subscripted Variables (Arrays: types of Arrays, DIMENSION Statement, Reading and Writing Arrays)Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine, RETURN, CALL, COMMON and EQUIVELENCE Statements), Structure, Disk I/O Statements, open a File, reading from a file. Examples from physics problems.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

[TOTAL THEORY CREDIT - 4]

THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:III (PRACTICAL)

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. Exercises on syntax on usage of FROTRAN.
2. To write the program and print out all natural even/odd numbers between given limits.
3. To write the program and find maximum, minimum and range of a given set of numbers.
4. To write the program and find a set of prime numbers and Fibonacci series.

Reference Books :

- Introduction to Numerical Analysis: S.S. Sastry, 5th Edn. 2012, PHI Learning Pvt. Ltd..
- Computer Programming in Fortran 77", V. Rajaraman (Publisher: PHI).
- Schaum's Outline of Theory and Problems of Programming with Fortran, S. Lipsdutz and A. Poe, 1986, McGraw Hill Book Co.
- Computational Physics: An Introduction, R.C. Verma, et al. New Age International.
- A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. 2007, Wiley India Edition.

FIRST YEAR SCIENCE – FIRST / SECOND SEMESTER
PHYSICS (GENERIC ELECTIVE)
PAPER – GE-I / GE-II (THEORY)

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT – I

Vector Analysis: Scalar and vector products, their derivatives. Triple Scalar and Triple Vector products, their properties. Gradient, Divergence, Curl and their physical significances. Vector integration, Line, Surface and volume integrals of vector fields, Gauss – divergence theorem and Stoke's theorem (statement only).

Conservation of linear and angular momentum of system of particles. Reduction of two body problem into an equivalent one body problem, Moment of Inertia of a solid cylinder and solid sphere. Rotational Kinetic energy and power.

UNIT – II

Gravitational Force, P.E. and potential, Gravitational potential and field at points due to thin spherical shell and a solid sphere, Kepler's laws, Derivation of Kepler's law from gravitational force, Satellite in circular orbit and applications, Geosynchronous orbits, Basic idea of global positioning system (GPS), Relation among elastic constants, Torsion of a right circular cylinder.

UNIT – III

Simple harmonic motion, Damped and forced oscillations.

Gauss' law in electrostatics, its applications and its differential form, electric field intensity due to spherical and plane charge distribution.

Lorentz force, Biot-Savart's law, magnetic field (B) due to straight conductor and circular coil carrying current. Ampere's circuital law and its differential form.

UNIT – IV

Fermat's principle, reflection and refraction at plane surface. Fresnel's and Fraunhoffer class of diffraction, Fresnel's half period zones, Zone plate, Fraunhoffer diffraction by single slit and double slit.

First law of thermodynamics, $C_p - C_v$, Equation of state for Adiabatic process. Carnot's engine, Carnot's theorem.

UNIT – V

Postulates of special theory of relativity, Lorentz Transformation, Length contraction, Time dilation. Relativistic addition of velocities, variation of mass with velocity. Einstein's mass-energy relation.

Growth and decay of currents in LR circuit containing DC source, Alternating Current in LCR circuit and its power.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Mathematical Physics: Satya Prakash, (Sultan Chand).
- Properties of Matter: D.S. Mathur (S. Chand).
- Heat and Thermodynamics: D.S. Mathur (S. Chand).
- Heat and Thermodynamics: J.B. Rajam.
- B.Sc. Physics: Part – I, II & III, K.N. Sharma.
- Physics for Degree Students, All Volumes: M. Bhunyan & others.
- Classical Mechanics: M. Das, P.K. Jena, M. Bhunyan and R.N. Mishra (Srikrishna Publication).

FIRST YEAR SCIENCE – FIRST / SECOND SEMESTER
PHYSICS (GENERIC ELECTIVE)
PAPER – GE-I / GE-II LAB (PRACTICAL)

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. Determination of 'g' by Bar pendulum.
2. Determination of 'Y' by Searle's apparatus.
3. Determination of 'Y' of India Rubber.
4. Determination of coefficient of viscosity by Stoke's method.
5. Verification of first law of transverse vibration of string by sonometer and hence to find absolute frequency of tuning fork.
6. Determination of refractive index of the supplied solid and liquid by Travelling microscope.
7. Determination of velocity of sound at 0° C using resonance column apparatus.

Reference Books :

- B.Sc. Practical Physics: Dr. B.B. Swain and others.
- B.Sc. Practical Physics: by Dr. C.L. Arora.

SECOND YEAR SCIENCE – THIRD / FOURTH SEMESTER
PHYSICS (GENERIC ELECTIVE)
PAPER – GE-III / GE-IV (THEORY)

Time – 3 Hours **Full Marks - 60**

(All units carry equal marks)

UNIT-I

Maxwell-Boltzmann's formula for distribution of molecular speed (statement, formula & discussions). Average. RMS and most probable speed. Principle of equipartition of energy. Vanderwaal's equation of state and derivation of critical constants.

Entropy. Change of entropy in a reversible process. Second law of thermodynamics. Mathematical formulation of second law of thermodynamics. Maxwell's thermodynamical relations. Claussius & Clayperon's equation.

UNIT-II

Thermal conductivity. Heat conduction along a bar. Rectilinear flow of heat. Ingen-Hausz experiment.

Black body radiation , emissive and absorptive power. Kirchoff's law, Stefaw-Boltzmann's law (no derivation), Wein's displacement law, Wein's distribution law & Rayleish-Jean's law (statement and discussion of formula). Planck's law & its derivation. Derivation of Wein's law and Rayleish-Jean's law from Planck's law.

Chromatic aberrations, achromatic combination (1) when the two bases are in contact, (2) separated by a finite distance, eye piece, Huygen's eye piece.

UNIT-III

Polarized and unpolarized light, Plane, Circularly and elliptically Polarized light, Polarization by reflection and refraction, Ordinary and Extraordinary rays, Nichol Prism, its construction , working as a analyzer and polarizer.

Maxwell's electromagnetic wave equations and their physical significance. Properties of E-M waves and speed.

Properties of nucleus, Mass defect, binding energy, packing fraction, Nuclear force. Nuclear fission, fusion. Linear accelerator.

Ionization and excitation potential, Franck-Hertz experiment.

UNIT-IV

Photo electric effect, Compton effect, dual nature of radiation, De-broglie hypothesis, Matter wave, Wave particle duality, Super position of two waves, Phase velocity, Group velocity, Wave packet, Davission-Germer experiment, Heisenberg's uncertainty principle.

Time dependent Schrodinger's equation in one dimension and three dimensions, Expectation value of an observable, Ehrenfest's theorem.

UNIT-V

Time independent Schrodinger equation. Its application to a particle in a box, Eigen values and Eigen functions. Potential step, reflection and transmission coefficient.

P-N junction, Half wave and full wave rectifiers, their efficiencies and ripple factors, working of N-P-N and P-N-P transistors, their static characteristics in CE and CB configurations , relation between α and β.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treaties on Heat: Meghnad Saha and B.N. Srivastava, 1969, Indian Press.
- University Physics, Ronald Lane Reese, 2003, Thomson Books / Cole.
- Thermal Physics: C Kittel and H. Kroemer (McMillan Education India), 2010.
- Fundamentals of Optics: F.A. Jenkins and H.E. White,1976, McGraw-Hill.
- Principles of Optics: B.K. Mathur, 1995, Gopal Printing.
- Fundamentals of Optics: H.R. Gulati and D. R. Khanna, 1991, S. Chand Publications.
- University Physics: F.W. Sears, M.W. Zemansky and H.D. Young, 13th Edn. 1986, Addison-Wesley.

SECOND YEAR SCIENCE – THIRD / FOURTH SEMESTER
PHYSICS (GENERIC ELECTIVE)
PAPER – GE-III / GE-IV LAB (PRACTICAL)

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. Determination of Y by bending of beam method.
2. Determination of rigidity modulus by static method.
3. Determination of rigidity modulus by dynamic method.
4. Determination of surface tension of water by capillary rise method.
5. Draw and study the static characteristics of a diode valve.
6. Draw static and mutual characteristics of a triode valve.
7. Variation of magnetic field along the axis of a circular coil.
8. Determination of ECE of copper using tangent Galvanometer.

Reference books:

- BSc . practical physics by Dr. B. B. Swain and others
- BSc . practical physics by Dr. C. L. Arora